

California Energy Commission
Alternative and Renewable Fuel and Vehicle
Technology Program

FINAL PROJECT REPORT

City of Monterey Park CNG Fueling System

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Prepared by: City of Monterey Park



California Energy Commission

Gavin Newsom, Governor

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PREFACE

Assembly Bill (AB) 118 (Núñez, Chapter 750, Statutes of 2007), created the Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP). The statute authorizes the California Energy Commission (Energy Commission) to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. AB 8 (Perea, Chapter 401, Statutes of 2013) re-authorizes the ARFVTP through January 1, 2024, and specifies that the Energy Commission allocate up to \$20 million per year (or up to 20 percent of each fiscal year's funds) in funding for hydrogen station development until at least 100 stations are operational.

The ARFVTP has an annual budget of approximately \$100 million and provides financial support for projects that:

- Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable alternative and renewable low-carbon fuels in California.
- Expand alternative fueling infrastructure and fueling stations.
- Improve the efficiency, performance and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
- Retrofit medium- and heavy-duty on-road and non-road vehicle fleets to alternative technologies or fuel use.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

To be eligible for funding under the ARFVTP, a project must be consistent with the Energy Commission's ARFVTP Investment Plan, updated annually. The Energy Commission issued PON-11-602 to provide funding opportunities under the ARFVTP for Alternative Fuels Infrastructure. In response to PON-11-602, the recipient submitted an application which was proposed for funding in the Energy Commission's Notice of Proposed Awards April 24, 2012, and the agreement was executed as ARV-12-014 on February 12, 2013.

ABSTRACT

The City of Monterey Park installed an upgraded Compressed Natural Gas (CNG) fueling station to expand the network of CNG fueling stations in the western San Gabriel Valley. The fueling system was installed at the City Yard that is located between the San Bernardino (10) and the Pomona (60) freeways, and four miles east of the Long Beach Freeway (710). The new CNG fueling system includes a credit card system to provide fuel to the general public.

Prior to the new CNG fueling system, the city relied on private fueling stations that are located over 9 miles away. In addition to the extra travel distance and fuel consumption, the city incurred higher fuel costs from purchasing fuel from private facility operators. Privately-owned fueling stations can charge more than double the cost of on-site, city generated CNG fuel; the market rate at the time of the final report is \$2.35 per gasoline gallon equivalent compared to \$1.49 per gasoline gallon equivalent.

The objectives of the project are to achieve carbon emissions targets that are set in the city's Climate Action Plan and to comply with air quality regulations. In order to accommodate the replacement of conventional fuel vehicles with CNG-fuel counterparts, sufficient and accessible CNG fuel was necessary. By the end of fiscal year 2017, the city's transit fleet of nine buses will all be CNG-fueled vehicles.

Keywords: California Energy Commission, City of Monterey Park, Southern California Gas Company, Alternative and Renewable Fuel and Vehicle Technology Program, Compressed Natural Gas, fueling system, carbon emissions, Climate Action Plan, air quality.

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EXECUTIVE SUMMARY

The City of Monterey Park expanded its small scale, time-fill compressed natural gas system to a public fueling station. The new system is strategically located at 751 South Alhambra Avenue at the city yard. The site is accessible to both the interstate 10 and 60 freeways from Garfield Avenue, a major north-south arterial in the western San Gabriel Valley.

The city elected to participate in a Compressed Services Tariff agreement with Southern California Gas Company (SoCalGas) in order to facilitate the design and construction of the station. SoCalGas owns the equipment for the term of the contract and is responsible for its maintenance and operation. The program only includes the compression equipment. The city was responsible for the purchase and installation of the dispenser and the credit card payment system.

The monthly compressed natural gas (CNG) fuel dispensed during the first six months is 6,309 gasoline gallon equivalent (gge). The city expects the throughput and emissions benefits to increase over time as more people become aware of the availability of the new CNG fueling station. At the time of this final report, the amount of CNG fuel dispensed in August 2016 was 6,940 gge.

CHAPTER 1:

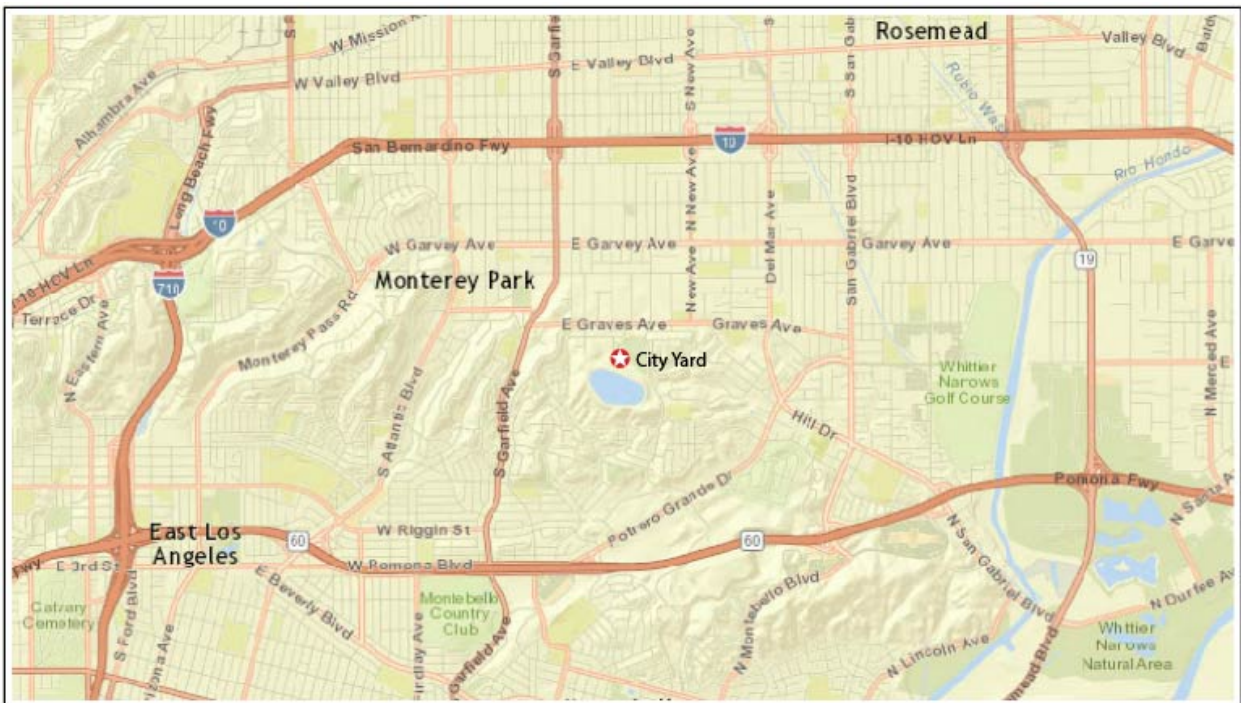
Project Purpose

Background

In 2005, the City of Monterey Park was awarded South Coast Air Quality Management District (AQMD) grant funding to install a slow-fill Fuel Maker Compressed Natural Gas (CNG) fueling system that would supply fuel for six Public Works light-duty trucks and one cutaway transit bus. Fuel Maker had since gone out of business and replacement parts for the equipment were not available. The slow-fill system had been out of service for the most part since 2010. The city struggled to keep the system running and resorted to used parts that had been taken from abandoned equipment.

Before the new CNG fueling system was built, the city relied on private fueling stations that are located over nine miles from the city yard, which is shown in Figure 1. The city's local bus service accrued additional travel time and fuel cost to access these stations. In addition, the city incurred higher fuel costs that are charged by private facility operators.

Figure 1: Location of City Yard

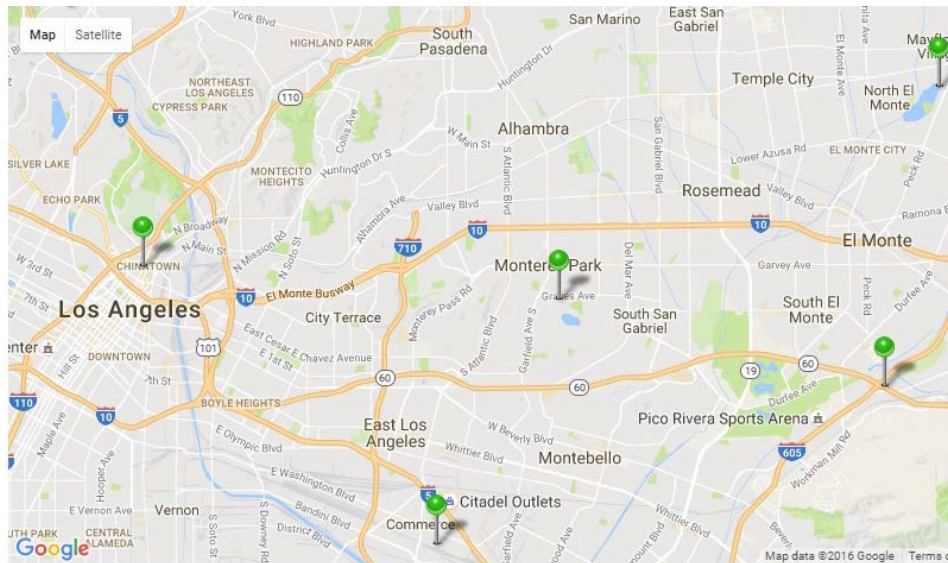


Source: City of Monterey Park

Figure 2 shows the map of CNG fueling stations that are open to the public and shows a gap in the vicinity of Monterey Park. While the city has made arrangements with the neighboring cities of Alhambra and El Monte to fuel at their CNG stations, the

agreement is on occasional and emergency basis only. Neither has the capacity to provide sufficient fuel for the daily, ongoing operation of the city's transit system.

Figure 2: Map of CNG Fueling Stations Open to the Public



Source: SoCalGas

City Fleet

The city has six light-duty, utility vehicles that are CNG-fueled. The city's utility fleet uses an average of 13 gasoline gallon equivalent (gge) per day, and operates an average of four and a half days a week. At this rate, the light-duty fleet of six CNG vehicles uses approximately 2,715 gge on an annual basis.

Transit System

The city's local, fixed-route transit fleet consists of nine buses: six heavy-duty mid-sized buses and three cutaway transit shuttles. Six of the nine are CNG-fueled vehicles: three heavy-duty mid-sized buses and three cutaway shuttles. The remaining three are diesel buses that are the oldest in the fleet and scheduled for replacement in fiscal year (FY) 2017. The transit service is contracted out to a private operator that maintains and operates the city-owned buses. At the completion of the service day, the vehicles are driven to the contractor's facility that is located outside of the city. This arrangement does not allow for the vehicles to be fueled overnight at time-fill posts.

The transit service consists of six routes that operate from 6:30 a.m. to 6:30 p.m. Monday through Friday, and four routes that operate from 9:00 a.m. to 5:00 p.m. on Saturday. There is no service on Sundays. The average monthly fuel consumption is 5,485 gge, or 65,820 gge per year.

Currently the diesel buses are used only as back-up vehicles. Upon their retirement, the additional CNG fuel used will be negligible.

The total annual CNG fuel consumed by all city vehicles is approximately 68,535 gge.

Private CNG Fuel

When the city purchased its first fleet of six CNG vehicles, CNG fuel was available at Eastern Avenue, in East Los Angeles about five miles from the city yard. Several years later, the station closed and staff was forced to find an alternative source for CNG fuel. The City of Alhambra offered the city access provided that usage was minimal and would not impact their operations.

When State and South Coast AQMD mandates required the conversion of the city's heavy-duty, diesel-fueled vehicles to alternative fuel, the city looked into in-house CNG fuel.

Approach

Public Works Construction Project

City Public Works construction projects require a bidding process that usually require two to four months to prepare specifications and bid packages, release public notices and obtain City Council authorization. Highly complex and technical projects – such as a CNG facility – would require additional time for staff to hire technical consultants to design the facility, prepare construction plans, and oversee construction. This additional step would require another one or two months to the schedule as staff would be required to conduct a Request for Proposal process to bring on board professional consultant services.

The city has an Engineering Division that consists of one Assistant City Engineer, two Associate Engineers, one Engineering Technician, and one Public Works Inspector. This staff of five oversees all construction projects within the city. In FY 2014, when the city was starting the process for the installation of the CNG fueling system, the Engineering Division was heavily involved with a number of Americans with Disabilities Act (ADA) improvements at city parks that were placed on high priority due to claims filed by constituents. The CNG fueling system project was already delayed due to discussions of relocating the city yard and when the decision to not relocate was made, the project was behind by nearly two years as the grant was approved in 2012.

SoCalGas Compression Services Tariff (CST)

To expedite the installation of the CNG Fueling System, city staff consulted its representative with the Southern California Gas Company (SoCalGas). SoCalGas representatives presented the city with the Compression Services Tariff (CST) option - a new program to assist cities with the installation of CNG fueling systems. This program provided a turnkey solution that included the design, bidding for construction, and oversight of installation. In addition, all maintenance would be the responsibility of SoCalGas. SoCalGas owns the equipment for the term of the contract and is responsible

for its operation. The program only includes the compression equipment. The city would be responsible for purchasing and installing the dispenser at an additional cost.

The CST charges the customer a monthly fee over a term of 5 to 15 years that is agreed upon by both parties. The city opted for a five-year time which resulted in the cost of \$11,862 per month or \$142,344 annually for five years. This payment plan is based on the down payment of \$450,000 (California Energy Commission's Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP) grant of \$300,000) and the Mobile Source Review Committee (MSRC) grant of \$150,000) that was signed over to SoCalGas at the commission of start-up.

CHAPTER 2:

Activities Performed

Implementation

Site Survey and Design

Per the CST arrangement, SoCalGas designed and built the new CNG system on city property. Dispenser equipment was not included in the CST. The compression facility was constructed within the city yard premise while the dispenser was located outside the fence line in order to allow for public access when the city yard is closed.

The CNG Station is an upgrade from an existing, slow-fill system that consisted of six time-fill posts and a fast fill system that were supplied by a 16 standard cubic feet per minute (scfm) compressor. The time-fill posts fueled six CNG-fueled light-duty utility vehicles. The new system includes two compressors, increasing compression capability to 150 scfm total. The twin compressor design was selected to provide the City with a redundant compressor system to provide as close to 100 percent uptime as possible. In addition to the new compressors, the upgrade includes motor starter control, a remote human machine interface (HMI) panel, a new manual regenerative dryer, three storage spheres and a dual-hose, public access dispenser that can fuel two vehicles simultaneously. The CNG station is also equipped with a communication device that allows for real time online monitoring capability.

The public access dispenser provides a fast fill with public access seven days a week from 7:00 am to 11:00 pm, Monday to Friday; 9:30 am to 11:00 pm, Saturday; and 7:00 am to 11:00 pm, Sunday. A video surveillance system is installed to monitor the CNG station for vandalism and other malicious activity when the area is deserted.

The public dispenser includes a card reader that accepts major credit cards. The fast fill can fuel the city's transit fleet that is contracted out for operations and maintenance and not stored at the city yard.

Key technical specifications include:

- Two natural gas compression skids, each rated at 50hp and 75 scfm, for a total of 150 scfm.
- Single tower natural gas dryer with manual regeneration.
- Three CNG storage spheres (each rated at 11,500 scf @4,500 psig, for a total of 34,500 scf).
- CNG electronic priority valve panel with Emergency Shut-Down.
- Electrical equipment including distribution panel board, Motor Starter Panel, Emergency shut-down buttons in required locations, sensor and control

conduit and wiring; and equipment grounding wires to existing grounding system.

- Natural gas supply piping between outlet of meter set assembly and inlet of SoCalGas' gas dryer and between dryer and compressor skid; and Valves, fittings, fire extinguishers and safety signs required for above equipment.
- Stainless steel pipings transporting compressed natural gas from compressors outlet to the dispenser.
- Electrical service upgrade that include an installation of utility transformer and a main switch board (breaker and feeder) to existing subpanel.
- Dual-hose dispenser (each rated at 3,600 psi) with NGV-1 nozzles and fuel management terminal equipped with a card reader for outside fleet access.

Figure 3: Aerial Photo of the City Yard Site



Source: City of Monterey Park

Construction

The SoCalGas project manager released the Request for Proposal for the construction on April 9, 2015 and conducted the job walk on April 15, 2015. Contract was awarded on May 4, 2015.

Construction was delayed due to a power upgrade that was necessary for the new compression equipment. The city had to install a new switchgear and two step down transformers. Several conceptual designs were proposed utilizing the existing infrastructure to feed power to the new CNG equipment. The scope of work and costs for the electrical upgrade was later incorporated into the CST through an amendment. The administrative time to take the amendment to Council for approval added another four weeks to the schedule and negotiations with southern California Edison added another four weeks. The project was essentially delayed by nearly two months as a result.

Figure 4: Photo of the Electrical Upgrades



Source: City of Monterey Park

A minor delay was the requirement of a deputy inspector on the cement pads. However, the SoCalGas project manager moved up the activities for the dispenser installation to try to keep the project on schedule.

Figure 5: Trenching For Conduits for Installation of Dispenser



Source: City of Monterey Park

Figure 6: Back Filling of Trenching For New Transformer (Electrical Upgrade)



Source: City of Monterey Park

Figure 7: Concrete Pad for Compressor Equipment



Source: City of Monterey Park

Figure 8: Dispenser in Foreground



Source: City of Monterey Park

Figure 9: Storage Tanks



Source: City of Monterey Park

Startup

The electrical upgrade was completed on June 26, 2015, and start-up of the compressor system was in the week of July 13, 2015.

While the compressor equipment was operational by the end of July, the integration of the dispenser and the fuel management system encountered several technical issues that delayed the opening of the station to the public. The city's fuel management system for unleaded and diesel fuel is Gasboy and the proposed system for the CNG fueling system is also Gasboy. Gasboy provided a turnkey solution for a credit card payment system and dispenser software but their sales representative staff were not familiar with setting up communications between their system and the City's existing server. Through trial and error, involvement of numerous city IT and support staff, and the installation of various new software and upgrades, the implementation of the credit

card payment system was completed after 3 months. The CNG compressor system was fully operational by the end of August 2015 but the credit card payment system that would provide access to the public was not available until the first week of December 2015.

Figure 10: Credit Card Payment System



Source: City of Monterey Park

Data Collection and Analysis

The new CNG dispenser is connected to the city's Gasboy Fuel Management System that tracks the amount of fuel dispensed by time and day per gas card that is issued to each eligible applicant/vehicle. In addition, the Gasboy Fuel Management System records sales transactions to the general public, providing the amount of fuel dispensed and the cost charged for that fuel.

Staff worked with SoCalGas to research emissions benefits from the CNG fueling system and created a calculation methodology to derive the emissions reductions by type of vehicle (for example, bus, utility vehicle, private automobile).

Cost information was incorporated into the analysis to calculate the cost to operate the CNG fueling system (for example, electricity and gas bills) and revenue generated from

the sale of fuel to the public. Finally, using the market rate for the purchase of CNG fuel from private stations, the City can determine cost savings from fueling onsite with city generated CNG fuel.

CHAPTER 3:

Results and Assessment

Fuel Consumption

Since the inception of the CNG fueling system (December 1, 2015), data has been collected on the fuel dispensed. The data is shown in Table 1.

Table 1: Monthly Fuel Dispensed

Month	Fuel Dispensed (gge)
December 2015	6,419.37
January 2016	5,562.76
February 2016	6,310.91
March 2016	6,378.93
April 2016	6,250.66
May 2016	6,933.34
Average	6,309.33

Source: City of Monterey Park

Cost Analysis

The cost charged to the public at the station from December 2015 to May 2016 was \$2.35. However the market rate fluctuated from a low of \$2.32 in December 2015 to a high of \$2.54 in January 2016. Table 2 details all costs associated with the operation of the CNG fuel system (such as utility cost) for each of the six months of data collection and the revenue generated from the sale of the fuel.

Table 2: Costs Associated With the Operation of the CNG Fuel System over the Six Month Data Collection

Fuel Cost	DEC 2015	JAN 2016	FEB 2016	MAR 2016	APR 2016	MAY 2016
CNG Fuel Dispensed (gge)	6,419.374	5,569.50	6,310.91	6,378.93	6,250.66	6,933.34
Natural gas usage (therms)	6,696	8,398	8,385	9,073	7,847	9,513
Fuel cost per gallon	\$0.51	\$0.77	\$0.68	\$0.66	\$0.59	\$0.68
Electricity usage (kWh)	5,230	6,366	7,899	6,544	6,375	7,468
Electricity cost per gallon	\$0.19	\$0.22	\$0.21	\$0.18	\$0.19	\$0.20
Maintenance Fee per gallon	\$0.43	\$0.50	\$0.44	\$0.43	\$0.44	\$0.40
Total cost per gallon	\$1.13	\$1.49	\$1.32	\$1.27	\$1.21	\$1.27
Vehicles Fueled						
City Public Works Utility Fleet	294.26	240.69	248.01	212.32	215.69	216.29
City Buses	5,877.97	4,893.58	5,120.24	5,110.07	5,075.95	5,321.45
Public Passenger Cars	153.17	152.80	206.87	255.04	260.50	402.88
Public Utility Trucks	93.977	282.422	735.783	801.503	698.517	992.72
Total	6,419.37	5,569.50	6,310.91	6,378.93	6,250.66	6,933.34
Cost Savings						
Private Fuel Market Rate (\$/gal)	\$2.32	\$2.54	\$2.54	\$2.54	\$2.54	\$2.45
Cost to Purchase Private Fuel	\$14,295.33	\$13,041.05	\$13,635.36	\$13,518.85	\$13,440.78	\$13,567.47
Net Savings	\$7,342.72	\$5,406.99	\$6,561.49	\$6,741.67	\$7,013.80	\$6,513.09
50¢/GGE Tax Credit	\$3,209.69	\$2,781.38	\$3,155.45	\$3,189.46	\$3,125.33	\$3,466.67
Total Savings	\$10,854.81	\$8,574.02	\$10,690.02	\$11,068.68	\$11,228.04	\$11,481.61

Source: City of Monterey Park

Emission Benefits

The specifications for the CNG station fuel throughput were derived based on the City's Spirit Bus fleet of eight vehicles. To date, the city has a fleet of six CNG buses that includes a CNG bus that was gifted to the city by Rio Hondo College. The remaining three diesel buses are proposed for replacement in FY 2017. The city hopes to have an entire fleet of nine CNG vehicles by the end of FY 2017. It should be noted that the diesel buses are rarely used and the additional CNG fuel consumed after the diesel buses are replaced with CNG counterparts is negligible.

Tables 3 and 4 detail the emissions calculations. Emissions are calculated based on the Low Carbon Fuel Standard (LCFS) – carbon intensity of natural gas compared to carbon intensity of gasoline and diesel - and the 2011 Carl Moyer's Emission Reduction and Cost-Effectiveness Calculations. Emissions are based on gallons of CNG fuel dispensed by type of vehicle (such as transit bus and utility vehicle).

Table 3: Greenhouse Gas Emissions (Average per Month)

Volume of natural gas dispensed at CNG Station (gge)	6,309.33
Percentage of CNG dispensed as substitute for diesel*	83%
Volume of natural gas dispensed at CNG Station (MMBtu)	819.98
Natural Gas Consumed as Transportation Fuel (MJ)	865,081
MJ substituting for gasoline	72,960
MJ substituting for diesel	792,121
Carbon Intensity Reduction - Gasoline (gCO ₂ e/MJ)**	19.59
Carbon Intensity Reduction - Diesel (gCO ₂ e/MJ)**	18.68
Green House Gas Emission Reduction (mt CO ₂ e)	16.23

*Percentage of total CNG fuel dispensed used for transit buses

**Based on the Following Projections

LCFS Gasoline Target Carbon Intensity (gCO ₂ e/MJ):	97.96
LCFS Diesel Target Carbon Intensity (gCO ₂ /MJ):	97.05

Source: City of Monterey Park

Table 4: NOx + PM10 (Average per Month)

Transit CNG Consumption (gge)			
	5,233		
Emissions	Factors (g/gal)	Grams	Tons
NOx Emission (Diesel)	89.69	469,336	0.5163
PM2.5 Emission (Diesel)	1.19	6,245	0.0069
PM10 Emission (Diesel)	1.25	6,527	0.0072
NOx Emission (0.2 NOx Nat G.)	3.70	19,362	0.0213
PM2.5 (0.2 NOx Nat G.)	0.17	890	0.0010
PM10 Emission (0.20 NOx Nat G.)	0.19	994	0.0010
Reduction In Emission	Grams	Tons	% Reduction
NOx	449,973	0.4950	96%
PM2.5	5,355	0.0059	86%
PM10	5,533	0.0061	85%

Source: City of Monterey Park

CHAPTER 4:

Conclusion

Advancements in Science and Technologies

The CNG Fueling System that was installed at the city's city yard can operate up to a pressure of 4,500 pounds per square inch gauge (psig). However, the compressors are controlled to shut off at 4,200 psig. This allows the high pressure gas to expand when stored in storage vessels and to avoid gas bleed off through the pressure safety/relief valve. The pressure safety/relief valve is factory set at 4,500 psig. On a hot summer day, the pressure in the storage vessels can elevate to as high as 4,400 psig. The compressor is a fully-lubricated type of compressor, which uses crankcase oil to lubricate the internal compression components. The fully lubricated compressor has a long component life and minimum downtime when an adequate maintenance plan is applied.

In addition to the compressor, a natural gas dryer is installed to remove moisture as the gas travels through a desiccant bed. The dryer is equipped with a dew point monitor device which signals an alert when the bed is saturated. An onboard regenerative system regens the saturated desiccant in a self-contained loop. During the regeneration process, the system continues to operate through a pass-by loop.

High pressure natural gas exiting the compressors enters a high pressure filter, located outside of the compressor, to remove any oil carryover. This eliminates the possibility for any compressor oil to enter the vehicle tank and potentially cause damage to the vehicle engine.

The bulk of the fuel demand is in the morning and evening when the city's transit buses fuel. Therefore, the CNG storage vessels are setup in a cascade fast fill configuration to satisfy the filling of the buses within the specific timeframe. Temperature compensation is functioned to ensure a full fill for a vehicle. The CNG system is equipped with the most liable programmable logic controller and HMI. The HMI offers a graphical illustration of the system condition during normal operation. The controller offers the flexibility to allow adjustment to the operating settings (critical and ancillary) in accordance to on-site conditions. The settings are password protected. The controller also has the capability to monitor numerous parameters, such as temperature, pressure, oil pressure, and gas pressure, at the same time. Furthermore, the onboard real time communication device allows the maintenance crews to monitor the system online and provide a proactive response before a failure condition can occur.

Figure 11: Human Machine Interface (HMI)



Source: City of Monterey Park

Recommendations

The CST with SoCalGas provided a valuable service to the City by providing a turnkey project. SoCalGas assigned a project manager who oversaw the design and construction from beginning to end. Their technical expertise was critical in moving the project forward expeditiously as city staff is not familiar with the equipment or the industry contacts. In addition, the city's engineering division includes only one Assistant City Engineer and two associates and they would not have been able to devote the time to oversee the design and construction of a project this size while also maintaining their daily workload. SoCalGas's expertise was critical in unforeseen obstacles such as the need to upgrade the electrical power.

The cost to the city to build the CNG Station via the CST Agreement was much higher than projected when the city put together the grant application to the Energy Commission in 2012. The Energy Commission grant contributed \$300,000 to the project that the city estimated would cost a total of \$776,000. This cost estimate was based on the city hiring a consulting firm to design the system and conducting a public works bid for construction. Construction oversight would be provided by city staff. Fortunately, when the city opted for the CST, MSRC awarded a grant of \$225,000 for this project that helped offset the additional cost.

Estimated cost:	\$300,000 Energy Commission Grant
	\$476,000 Local Match
	\$776,000 Total

Actual cost:	\$300,000 Energy Commission Grant
	\$225,000 MSRC Grant

\$711,720 CST monthly payments for five-year term (Local Match)
\$80,500 dispenser cost (Local Match)
\$1,317,220 Total

The lesson learned from the CST arrangement with SoCalGas is that partnering with other entities and joint collaborative efforts can have a high payback. Not only does city staff have a better understanding of CNG fuel, SoCalGas became educated on the city processes for procurement and permitting. The city also has the distinction of one of the first entities to execute the CST and has been sharing its experiences with other cities that are considering this option to building their CNG facilities.

Acronyms

AQMD	Air Quality Management District
ARFVTP	Alternative and Renewable Fuels and Vehicle Technology Program
ADA	Americans with Disabilities Act
CNG	Compressed Natural Gas
CST	Compression Services Tariff
HMI	Human Machine Interface
LCFS	Low Carbon Fuel Standard
MSRC	Mobile Source Air Pollution Reduction Review Committee
SoCalGas	Southern California Gas Company